The Patent Office

GB04/00060

INVESTOR IN PEOPLE

The Patent Office
Concept House
Cardiff Road
Newport
South Wales
NP10 8QQ

REC'D 17 MAY 2004
WIPO PCT

PRIORITY DOCUMENT

SUBMITTED OR TRANSMITTED IN COMPLIANCE WITH RULE 17.1(a) OR (b)

I, the undersigned, being an officer duly authorised in accordance with Section 74(1) and (4) of the Deregulation & Contracting Out Act 1994, to sign and issue certificates on behalf of the Comptroller-General, hereby certify that annexed hereto is a true copy of the documents as originally filed in connection with the patent application identified therein.

In accordance with the Patents (Companies Re-registration) Rules 1982, if a company named in this certificate and any accompanying documents has re-registered under the Companies Act 1980 with the same name as that with which it was registered immediately before re-registration save for the substitution as, or inclusion as, the last part of the name of the words "public limited company" or their equivalents in Welsh, references to the name of the company in this certificate and any accompanying documents shall be treated as references to the name with which it is so re-registered.

In accordance with the rules, the words "public limited company" may be replaced by p.l.c., plc, P.L.C. or PLC.

Re-registration under the Companies Act does not constitute a new legal entity but merely subjects the company to certain additional company law rules.

Signed

Dated 10 May 2004

BEST AVAILABLE COPY

14JAN03 E776556-1 C59521
P01/7700 0.00-0300683.0

Patents Form 1/77

Patents Act 1977

THE PATENT OFFICE
C
11 JAN 2003
NEWPORT

The Patent Office

1/77

Request for grant of a patent
Grant

11 JAN 2003

The Patent Office
Concept House
Cardiff Road
Newport
Gwent NP10 8QQ

1.	Your reference	2040-P144-GB
2.	Patent application number	0300683.0 NEW
3.	Full name, address and postcode of the or of each applicant *(underline all surnames)*	ELEKSEN LIMITED Charter Court Midland Road Hemel Hempstead Hertfordshire HP2 5GE United Kingdom
	Patents ADP number *(if you know it)*	82889 2 0001
	If the applicant is a corporate body, give the country/state of its incorporation	United Kingdom
4.	Title of the invention	MANUALLY DEFORMABLE INPUT DEVICE
5.	Name of your agent	ATKINSON BURRINGTON
	"Address for service" in the United Kingdom to which all correspondence should be sent	25-29 President Buildings President Way Sheffield S4 7UR GB
	Telephone No:	0114 275 2400
	Patents ADP number	7807043001

		Country	Priority application number *(if you know it)*	Date of filing *(day/month/year)*
6.	If you are declaring priority from one or more earlier patent applications, give the country and the date of filing of the or of each of these earlier applications and *(if you know it)* the or each application number	N/A	N/A	N/A

		Number of earlier application	Date of filing (day/month/year)
7.	If this application is divided or otherwise derived from an earlier UK application, give the number and the filing date of the earlier application	N/A	N/A

8.	Is a statement of inventorship and of right to grant of a patent required in support of this request?	YES

Patents Form 1/77

9. Enter the number of sheets for any of the following items you are filing with this form. Do not count copies of the same document

Continuation sheets of this form	
Description	19
Claim(s)	03
Abstract	00
Drawings	20

10. If you are also filing any of the following, state how many against each item.

Priority documents	N/A
Translations of priority documents	N/A
Statement of inventorship and right to grant of a patent (*Patents Form 7/77*)	NONE
Request for preliminary examination and search (*Patents Form 9/77*)	ONE(1)
Request for substantive examination (*Patents Form 10/77*)	NONE
Any other documents (*Please specify*)	

11. I/We request the grant of a patent on the basis of this application.

Signature

Date Friday, 10 January 2003

12. Name and daytime telephone number of person to contact in the United Kingdom

RALPH ATKINSON CPA
0114 275 2400

SR-01-083

DUPLICATE

Manually Deformable Input Device

Background of the Invention

1. Field of the Invention

The present invention relates to a manually deformable input device responsive to manually applied pressure. The input device may have control applications, such as controlling a motor or providing an input command to a game. Alternatively, the input device may be used to monitor conditions and, for example, to provide an output signal so as to raise an alarm condition.

2. Description of the Related Art

A deformation sensitive electroconductive device is disclosed in United States Patent 4,715,235 in which a knitted or woven fabric has electroconductivity that changes in response to the fabric experiencing a deformation. In a detailed embodiment, a fabric is applied over a finger of an operative and finger movement is detected by detecting changes in the resistivity of the fabric. The fabric is modelled as a variable resistance and the resistivity of the fabric is measured in order to determine that a movement has been made.

A problem with fabrications of this type is that the resistive fabric element will undergo resistance changes in response to other changing conditions, such as temperature and ageing etc. such that its effective sensitivity significantly reduces the available applications for the device. Consequently, it is unlikely that the system described in the aforesaid US Patent could reach a satisfactory commercial realisation; other technologies

being preferable for their inherent stability features.

It has been realised that fabric solutions do have advantageous application in some situations, particularly if costs are to be reduced or if the control mechanism is to be incorporated within soft structures or products. Thus, for example, it is possible that devices of this type could be used to make modifications to the position and orientation of seats in vehicles in preference to additional mechanical switches etc. Thus, in such an application, in preference to switches being operated manually, portions of a car seat itself could be manipulated so as to effect movement and reconfiguration. Such an approach may reduce production costs while providing a more elegant and attractive solution.

Brief Summary of the Invention

According to an aspect of the present invention, there is provided a manually deformable input device responsive to manually applied pressure, comprising a deformable resilient element configured to deform in response to said manually applied pressure; an electroconductive material applied over said resilient element and configured to exhibit changes in conductance (resistance) in response to being stretched; and an electrical interface device configured to supply electrical current through said fabric via a first terminal and a second terminal; wherein a third terminal is connected at an intermediate position; and said interface device is configured to receive a voltage from said third terminal.

Brief Description of the Several Views of the Drawings

Figure 1 shows an electroconductive yarn;

Figure 2 illustrates a weft knit;

Figure 3 shows the weft knit of *Figure 2* after it has been stretched;

Figure 4 illustrates a relationship between resistance change and elongation;

Figure 5 details a linear region identified in *Figure 4*;

Figure 6 shows a manually deformable input device embodying the present invention;

Figure 7 illustrates the relationship between stretch and resistance of the device shown in *Figure 6*;

Figure 8 illustrates an electrical model of the device shown in *Figure 6*;

Figure 9 further illustrates the relationship between stretch and the resistance change for the device shown in *Figure 6*;

Figure 10 shows an alternative embodiment;

Figure 11 shows a top view of the embodiment shown in *Figure 10*;

Figure 12 further illustrates the alternative embodiment of *Figure 10*;

Figure 13 details the interface circuit for the device shown in *Figure 10*;

Figure 14 illustrates the device of *Figures 10* and *11* connected to the interface circuit shown in *Figure 13*;

Figure 15 shows an alternative embodiment;

Figure 16 shows an alternative embodiment;

Figure 17 further illustrates the alternative embodiment of *Figure 16*;

Figure 18 details procedures performed by the interface circuit for the embodiment shown in *Figure 16*;

Figure 19 shows an application of the device of *Figure 16*;

Figure 20 illustrates the configuration shown in *Figure 19* in use.

Written Description of the Best Mode for Carrying Out the Invention

Figure 1

An electroconductive yarn is shown in *Figure 1*, constructed from an electrically conductive yarn **101** and an electrically insulating yarn **102**. In this preferred embodiment, the electrically conductive yarn **101** is wrapped around the insulating yarn **102**. The conductive yarn may be fabricated from a conventional yarn having a carbonised or metallised outer surface and the insulating yarn **102** may be fabricated from polyester. In this example, the conductive yarn **101** has a size of twenty-four decitex whereas the insulating yarn **102** has a size of twelve decitex. According to a preferred embodiment, six filaments of twenty four decitex carbon coated nylon are twisted together with twelve filaments of twelve decitex polyester yarn. By using conducting yarn having a diameter greater than the insulating yarn, the twisted composite yarn can be formed with prominent conductive elements at the surface.

It can be appreciated that an electrical current may flow down the conductive yarn **101**. In addition, when yarns are in close proximity, or loops of the same yarn are in close proximity, a current may also flow between the yarns or loops. Furthermore, when yarns are in close proximity planar resistance tends to reduce, whereas forcing the yarns away from each other, by a stretching operation for example, results in the overall planar resistance increasing.

Figure 2

A construction that emphasises the effect of resistance changes with respect to stretch is illustrated in *Figure 2*. This consists of a weft knit where individual yarns **201** run from a left position **202** to a right position **203**. In a preferred application, a voltage is applied across the plane so as to promote current flow in the direction of arrow **204**; that is to say substantially perpendicular to the direction of the individual conducting yarns, i.e. in the warp direction.

An electroconductive material that exhibits a change of resistance in response to stretching can be created using other constructions including warp knit, weave and crochet constructions; and may incorporate composite yarn, such as the conductive yarn shown in *Figure 1*, yarn comprising staple or monofilament fibres, or elastic fibres, for example in a yarn having conductive or insulating fibres wrapped around an elastic centre. In addition, conductive yarn and insulating yarn may be twisted together prior to the construction process or, for example, conductive yarn can be incorporated during the construction process. Thus, electroconductive materials with different characteristics can be created using different constructions, materials and, for example, stitch sizes.

Figure 3

The weft knit construction illustrated in *Figure 2* is also shown in *Figure 3*, after the material has been stretched in the direction illustrated by arrow **301**. This has resulted in an increase in the separation between the individual yarns such that fewer paths now exist for current flow and hence

the planar resistance has increased. Thus, it is possible for this property to be used in order to determine the extent of stretch which in turn may be related back to an extent of manually applied pressure.

According to an alternative warp knit construction (not shown) conductive in the warp direction, the planar resistance decreases in response to stretching in the warp direction. Thus, although this type of construction responds differently to the described weft knit construction shown in *Figures 2* and *3*, it possesses the same property of exhibiting a change in resistance in response to being stretched, from which an extent of manually applied pressure can be determined.

Figure 4

A relationship between resistance change and sheet elongation is illustrated in *Figure 4*. It can be seen from *Figure 4* that for the weft knit fabric shown in *Figures 2* and *3*, a percentage increase of elongation of approximately forty percent results in a resistance change of approximately five hundred percent. Furthermore, for elongations between zero and forty percent the increase in resistance is relatively linear. For elongation beyond forty percent the relationship tends to become non-linear. Thus, the linear portion provides a preferred operational region for control purposes.

Figure 5

The linear region of operation identified in *Figure 4* is detailed in *Figure 5*. Thus, by measuring resistance change it is possible to identify percentage elongations over a range of zero to forty percent.

Figure 6

A manually deformable input device responsive to manually applied pressure is detailed in *Figure 6*. The device includes a deformable resilient element **601**. Resilient element **601** may be fabricated from closed cell foam, elastomeric silicone rubber or similar elastomeric materials. The deformable element **601** is covered with an electroconductive material **602** such as the weft knit material illustrated in *Figure 2*. Thus, electroconductive material **602** is configured to exhibit changes in conductance (resistance) in response to being stretched.

Stretching occurs locally by moving the resilient element **601** in the directions illustrated by arrow **603**, which results in one side of the device experiencing elongation while the opposite side of the device experiences compression. Alternatively, stretching occurs when pressure is applied to a region of the deformable element **601**, for example a discrete region on one side of the deformable element **601** only, which results in deformation of one side of the deformable element **601** relative to the other. In addition, the electroconductive material **602** has a thickness that is responsive to manually applied pressure. A relationship exists between the thickness and the conductivity of electoconductive material **602**, such that a change in the thickness of the material **602** under manually applied pressure results in a corresponding change in conductivity. Thus, electroconductive material **602** is responsive to different types of manipulation of the resilient element **601**.

An electrical interface device **604** is configured to supply electrical current via a first terminal **605** and a second terminal **606**. Thus, with a current flowing from terminal **605** to terminal **606**, the resistance of the

electroconductive material **602** results in a voltage drop occurring between said first and second terminals.

A third terminal **607** is connected at an intermediate position **608** within the conductive fabric. The interface device **604** receives a voltage from said third terminal **607** representing a proportion of the voltage drop occurring through the conductive material. Thus, in this way, the third terminal **607** provides a tap into the divided voltage at the position of the central conductor **608**. The total configuration therefore operates as a potential divider sensitive to manual operation irrespective of the absolute resistance of the overall fabric. Thus, in this way, it is possible to obtain significantly higher levels of sensitivity and predictability such that the mechanism may be used in many control situations where known technologies, merely directed towards measuring resistance per se, would not be applicable.

Figure 7

The relationship between stretch and resistance, for the device shown in *Figure 6* is illustrated in *Figure 7*. When force is applied in the direction of arrow **701**, the device is elastically forced from the position shown at **702** to, for example, a position shown at **703**. This results in a left wall **704** being elongated while a right wall **705** is compressed.

An electromotive force of three volts is applied across terminals **605** and **606**. Before a manual force is applied, resistances **706** and **707** will tend to be substantially equal such that the voltage appearing at the third terminal **607** will tend to be 1.5 volts; i.e. the voltage is being divided substantially equally. As force is applied, resulting in the device being bent towards position **703**, the compression applied to resistance **707** will tend to reduce

resistance whereas the extension applied to resistance **706** will tend to increase its resistance. With the resistance at **706** being increased, there will tend to be a greater voltage drop across this resistance with a relatively lower voltage drop occurring across resistance **707**. Thus, for example, when stretched to position **703**, two volts may be measured at the third terminal **607**. Thus, detecting a voltage change from 1.5 volts to 2 volts over the linear period of operation, as illustrated in *Figure 5*, allows a relatively accurate measurement to be determined as to the extent of bending that has occurred between positions **702** and **703**.

Figure 8

An electrical model of the device shown in *Figure 6* is illustrated in *Figure 8*. This consists of a first variable resistor **801** in series with a second variable resistor **802**. A central tap **803** completes the potential divider. Thus, as previously described, a voltage is applied across terminal **605** and **606** and the divided voltage is measured at the third terminal **607** via tap **803**.

The nature of the device is such that the variable resistors **801** and **802** may be considered as being ganged. However, an inverse relationship typically exists between the variable resistors such that an operation to increase the resistance of one will normally result in a decrease of the resistance of the other. However, it should be appreciated that in the actual device relative rates of change will differ. Consequently, bending of the device will tend to increase the resistance of the stretched resistor to a greater extent than a decrease in the resistance of the compressed resistor. Thus, the configuration provides a potential divider that appears similar to a potentiometer but has somewhat different operational characteristics. For

example, a change in the magnitude of one resistance may be exhibited while the magnitude of the other resistance may be substantially maintained.

Figure 9

A further representation of the relationship between resistance changes and bending is illustrated in *Figure 9*. In its unbent condition, each side of the conductive fabric displays a resistance of five thousand ohm (5k) and the applied voltage of three volts is divided equally. Consequently, the voltage measured at the third terminal is substantially 1.5 volts.

As the device is bent to the right, as shown at **901**, the stretched resistance **902** will tend to increase and the compressed resistance **903** will tend to decrease. Thus, a greater voltage drop will occur across resistance **902** resulting in the tapped voltage reducing from 1.5 volts to one volt.

Similarly, if the device is bent to the left, as illustrated at **904**, resistance **902** will tend to decrease while resistance **903** will tend to increase. Consequently, in this example, the tapped voltage has increased from 1.5 volts to two volts.

However, the present invention provides a manually deformable input device that is responsive to other forms of manipulation. Different patterns of voltage change can be related to different types of manipulation and device structure. For example, a manually deformable input device having the electrical configuration of the device shown in *Figure 6* can be utilised within a car seat cushion, in which the cushion is supported on the underside by a substantially rigid panel, and the topside is exposed to allow manual manipulation of the cushion. With this arrangement, the cushion deforms under the weight of a person sitting upon it, however, deformation of the

underside of the cushion is negligible relative to the deformation of the topside of the cushion. Consequently, a significantly greater change in conductivity of the topside of the cushion, compared to the underside, occurs. Thus, a change in conductivity of the topside relative to the underside is exhibited, from which deformation can be detected. In this example, the detected deformation is primarily compression or indentation in nature, resulting from, for example, a person pressing the cushion with a finger.

Such a cushion may comprise a single manually deformable input device, or may comprise a plurality of such devices, such that deformation in different areas of the cushion can be detected. Such a cushion can be utilised as a control or control panel, or as a monitoring aid to monitor, for example, the length of time a person is sitting, the frequency of use of a seat, or the sitting position of one or more persons.

Figure 10

An alternative embodiment is illustrated in *Figure 10.* A deformable resilient element **1001** is responsive to deformation in two dimensions, illustrated by a first arrow **1002** and a second arrow **1003**. The device has a substantially square cross-section defining four vertical surfaces; a first **1004** and a second **1005** surface are shown in the Figure, with a third **1006** and a fourth surface **1007** being on the reverse side. Each vertical surface **1004** to **1007** has a conductive fabric applied thereto; specifically, fabric **1008** applied to surface **1004** and the fabric **1009** being applied to surface **1005**. An electrical terminal is connected to the bottom of each conductive fabric **1004** to **1008**; specifically, terminal **1010** applied to conductive fabric **1008** and terminal **1011** being applied to conductive fabric **1009**. The conductive fabrics

are electrically connected towards the top of the device by means of a conductive band **1012**. According to the present embodiment, to simplify construction of the device, a separate voltage dividing tap is not provided. In operation, current is applied through opposing conductive surfaces while a third surface provides the voltage dividing tap. By scanning pairs of opposed conducting surfaces in alternating sequence, deformation in the two illustrated dimensions can be detected. Using similar conductive material on each surface of a pair offsets effects resulting from changes in temperature, humidity etc.

According to an alternative embodiment, a separate voltage dividing tap connected to conductive band **1012** is provided. According to a further alternative embodiment, two manually deformable input devices according to the embodiment described with reference to *Figures 6* to *8* are placed upon deformable resilient element **1001**, such that deformation can be detected in the two illustrated directions and two voltage dividing taps are provided.

Figure 11

A top view of the device illustrated in *Figure 10* is shown in *Figure 11*. In addition to terminals **1010** and **1011** (shown in *Figure 10*) terminals **1101** and **1102** are also shown in *Figure 11*. Terminal **1010** is connected to conductive fabric **1008** and terminal **1011** is connected to conductive fabric **1009**. Similarly, terminal **1101** is connected to conductive fabric **1003** and terminal **1102** is connected to conductive fabric **1004**; applied to vertical surface **1006** and **1007** respectively.

Figure 12

An electrical representation of the configuration shown in *Figures 10* and *11* is illustrated in *Figure 12*. This consists of four variable resistors **1201, 1202, 1203** and **1204** each connected to a central point **1205**.

Figure 13

An interface circuit **1301** for the device shown in *Figures 10* and *11* is shown in *Figure 13*. The interface circuit includes a PIC processor **1302** configured to supply output signals to terminals and to receive input signals from terminals. The device includes four interface terminals **1303**, **1304, 1305** and **1306**. Terminal **1303** connects to **1010**, terminal **1304** connects to **1011**, terminal **1305** connects to terminal **1102** and terminal **1303** connects to terminal **1101**.

Under program control, output voltages are generated by the processor **1302**, from pins ten, eleven, twelve and thirteen. Similarly, input voltages are received at pins seventeen and eighteen via buffer amplifier stages **1307** and **1308**. In operation, voltage is applied across terminals **1303** and **1305** resulting in a voltage being applied across terminals **1010** and **1102**. A voltage is received at terminal **1305** and supplied to the PIC processor via amplifier **1308**. This is then followed, in a multiplexed fashion, by a voltage being applied across terminals **1304** and **1305** such that an input voltage may be received on terminal **1303** and supplied to the PIC processor via buffer amplifier **1307**. Response details are stored within the PIC processor **1302** thereby allowing it to produce an output signal on an output terminal **1309** indicative of the degree of, for example, bending.

Figure 14

The input device of *Figures 10* and *11* is shown connected to the interface circuit of *Figure 13* in *Figure 14*. The interface circuit **1301** applies a voltage across surfaces **1008** and **1104** whereafter a tapped input voltage is received from surface **1103** and applied to input terminal **1305**. After an input measurement has stabilised, the output voltage is removed to be replaced by an alternative output voltage across surfaces **1009** and **1103**. Subsequently, an input voltage is received from surface **1008** and applied to input terminal **1303**.

The PIC processor performs appropriate calculations to determine the nature of the displacement of the device to provide an output signal at terminal **1309**. In this example, the output signal is supplied to a power amplifier **1401** which in turn drives an actuator **1402**. The actuator could, for example, be a motorised car seat adjustment motor or any other appropriate device controlled by manipulation of the input device.

Figure 15

An alternative embodiment similar to the embodiment shown in *Figure 10* is identified in *Figure 15*. Deformable resilient element **1501** is implemented by an insulating foam. Four strips of electroconductive material **1502**, **1503**, **1504** and **1505** are implemented as conductive foam. The conductive foam is substantially similar to the insulating foam but includes particles or fibres of conducting material. Consequently, when stretched, the conducting components are placed in a condition of greater separation thereby increasing overall resistance. Similarly, compression brings more of

the conductive components together and therefore increases conduction. Alternative conductive materials include other elastomeric insulating materials such as silicon or rubber filled with conducting particles or fibres.

A conductive band **1506** electrically connects the conductive foam sections **1502** to **1505** at a top end with the bottom end of the conductive foam sections being connected to terminals and then to an interface circuit substantially as illustrated in *Figure 14*.

Figure 16

An alternative embodiment is shown in *Figure 16*, capable of detecting movement in all six degrees of freedom; namely translation in the X, Y and Z directions along with rotation about the X, Y and Z axes. A deformable resilient element **1601** is substantially frusta-conical, with its larger substantially circular base **1602** being firmly attached to a substrate such that it is firmly held into position on a table top or similar structure. An upper surface **1603** of the resilient element **1601** has an extension portion **1604** extending therefrom to facilitate manual manipulation.

Six electroconductive material portions are applied over the deformable resilient element **1601** in a substantially diagonal configuration running from a first lower electrical connector to an upper joint and then returning to a further lower connector. The combination therefore has a total of six lower connectors **1611, 1612, 1613, 1614, 1615** and **1616**. The upper joints are displaced centrally between the lower connectors at upper joint locations **1621, 1622, 1623**. A first variably conductive material section **1631** is positioned between lower connector **1612** and upper joint **1621**. A second variably conductive material section **1632** is applied between upper joint

1621 and lower connector **1613**. Similarly, a third variably conductive material section **1633** is positioned between lower connector **1614** and upper joint **1622**. A fourth variably conductive material section **1634** is positioned between upper joint **1622** and lower connector **1615**. A fifth variably conductive material section **1635** is positioned between lower connector **1616** and upper joint **1623**. Finally, a sixth variably conductive material section **1636** is positioned between upper joint **1623** and lower connector **1611**. Upper joints **1621** to **1623** are electrically connected by a conductive band. In this example, conductive band **1641** comprises metallised woven fabric and is connected using pressure sensitive conductive adhesive. Thus, it is possible to supply current through sections **1631** and **1632** by the application of a voltage across connectors **1612** and **1613**. Similarly, it is possible to apply a current through sections **1633** and **1634** by the application of a voltage across connectors **1614** and **1615**. Finally, a current may also flow through sections **1635** and **1636** by the application of a voltage across connectors **1616** and **1611**.

Figure 17

An electrical model for the configuration of *Figure 16* is shown in *Figure 17*. In the model shown in *Figure 17*, six variable resistors are commonly connected at **1641** and each present a terminal **1611** to **1616**.

Figure 18

The input device of *Figure 16* is connected to an interface device substantially similar to that shown in *Figure 13*, but with additional input/outputs and current measuring means. The current measuring means

may comprise a fixed resistor connected to, for example, each of connectors **1611**, **1613** and **1615**, that can be switched to and from ground. Procedures performed by the interface device are multiplexed, as illustrated in *Figure 18*. Thus, an energising cycle consists of nine stages **1701** to **1709**. Stages **1701** to **1706** involve voltage measurement, whereafter sufficient information has been received in order to define a three-dimensional movement of the deformable element within six degrees of freedom. The information can be processed in accordance with known systems, such as Stewart bridge analysis. Stages **1707** to **1709** involve current measurement, whereafter sufficient information has been received in order to identify compression or indentation of the deformable element.

At step **1701** a voltage is applied to connector **1612**. Connector **1613** is grounded and an output voltage is measured at connector **1614**. It is possible, however, to apply a voltage across connectors **1612** and **1613** and to connect an input buffer with high input impedance to connector **1614** or any other connector that is otherwise unused during this measurement, and to measure voltage at conducting band **1641**. At step **1702** an input voltage is applied to connector **1613**, connector **1614** is grounded and an output voltage is measured at connector **1615**. At step **1703** an input voltage is applied to connector **1614**, connector **1615** is grounded and an output voltage is measured at connector **1616**. At step **1704** an input voltage is applied at connector **1615**, connector **1616** is grounded and an output voltage is measured at connector **1611**. At step **1705** an input voltage is applied to connector **1616**, connector **1611** is grounded and an output voltage is measured at connector **1612**. Voltage measurement is completed, at step **1706**, by an input voltage being applied to connector **1611**, connector

1612 being grounded and an output voltage being measured at connector **1613**.

Steps **1707** to **1709** involve current measurement. At step **1707** a voltage is applied to connector **1612** and a current is measured at connector **1613**. At step **1708** a voltage is applied to connector **1614** and the current is measured at connector **1615**. Finally, at step **1709** a voltage is applied to connector **1616** and a current is measured at connector **1611**.

The resistance of the six variably conductive material sections **1631** to **1636** either increase or decrease, according to the construction of the material, in response to the deformable element deforming under an applied squeezing action. The current measurements performed at steps **1707** to **1709** provide an indication as to the current flowing through the deformable element, which may be related to an extent of pressure applied to the deformable element. Thus, steps **1707** to **1709** provide for a squeezing, compressing or denting action applied to the deformable element to be detected, and hence compression or indentation of the deformable element to be detected.

The multiplexed procedure sequence detailed in *Figure 8* can be executed according to one of two modes, namely monitoring mode and active mode. In monitoring mode, steps **1701** to **1706** are performed at a first scan rate to minimise power consumption, and when motion is detected, steps **1701** to **1709** are performed at a second faster scan rate in active mode, during which full sets of measurements are obtained.

Figure 19

An application for a device of the type shown in *Figure 16* is shown in *Figure 19*. A portable deformable input device **1901** is attached to a base plate **1902**, configured to be supported by a solid object. A clamp **1903** has been attached to the top of the deformable input device **1901** configured to receive a manually-operable games controller **1904**. Thus, with the games controller **1904** being supported within the clamp **1903** it is possible for a game player to provide additional information to an appropriately programmed game. Thus, for example, a configuration of this type would be particularly suitable for 3D action games and flight simulators etc. In addition to receiving an input from the controller **1904** a computer system also receives an input from an interface device associated with the deformable input device **1901** possibly over a serial or a USB computer interface.

Figure 20

The configuration shown in *Figure 19* may be used in a situation as shown in *Figure 20*. Thus, base plate **1902** is supported by a chair and the deformable input device is thus held down by a user's legs. The control device **1904** is then held in an orientation substantially similar to that of a steering wheel or similar input device thereby providing the user with a realistic and enhanced operation stance thereby significantly enhancing the interaction with the game or program itself; all achieved by use of a relatively inexpensive, durable additional control apparatus.

Claims

1. A manually deformable input device responsive to manually applied pressure, comprising

a deformable resilient element configured to deform in response to said manually applied pressure;

an electroconductive material applied over said resilient element and configured to exhibit changes in conductance (resistance) in response to being stretched; and

an electrical interface device configured to supply electrical current through said fabric via a first terminal and a second terminal, wherein:

a third terminal is connected at an intermediate position; and

said interface device is configured to receive a voltage from said third terminal.

2. An input device according to claim **1**, wherein said resilient element is constructed from a foam-like material.

3. An input device according to claim **1**, wherein said resilient element is constructed from rubber or silicone rubber.

4. An input device according to claim **1**, wherein said electroconductive material is a textile fabric.

5. An input device according to claim **4**, wherein said fabric is a warp knit, a weft knit or a weave that includes conductive fibres.

6. An input device according to claim **1**, wherein said electroconductive material is an elastomeric material having electroconductive components therein.

7. An input device according to claim **1**, wherein the resistance of said electroconductive material increases when said material is stretched.

8. An input device according to claim **1**, wherein the resistance of said electroconductive material decreases when said material is stretched.

9. An input device according to claim **1**, wherein said interface device is configured to measure a divided voltage between said first terminal and said second terminal.

10. An input device according to claim **1**, wherein said interface device is configured to produce an output signal.

11. An input device according to claim **10**, wherein said output signal is used to:

control a motor;

provide an input command to a game;

12. An input device according to claim **1**, wherein said output signal is used to raise an alarm condition.

13. An input device according to claim **1**, configured to be responsive to translation of said deformable resilient element.

14. An input device according to claim **1**, configured to be responsive to rotation of said deformable resilient element.

15. An input device according to claim **1**, configured to be responsive to compression or indentation of said deformable resilient element.

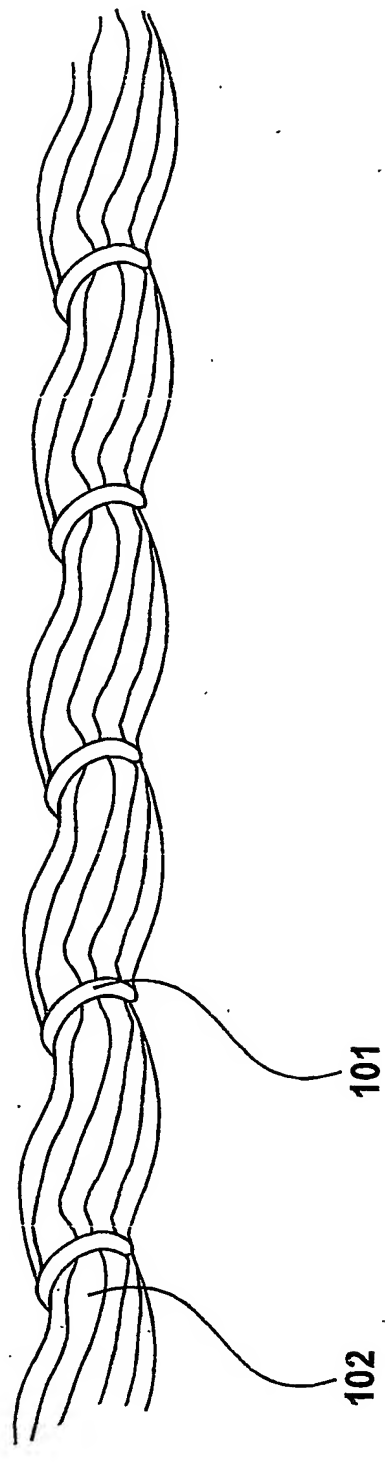

Figure 1

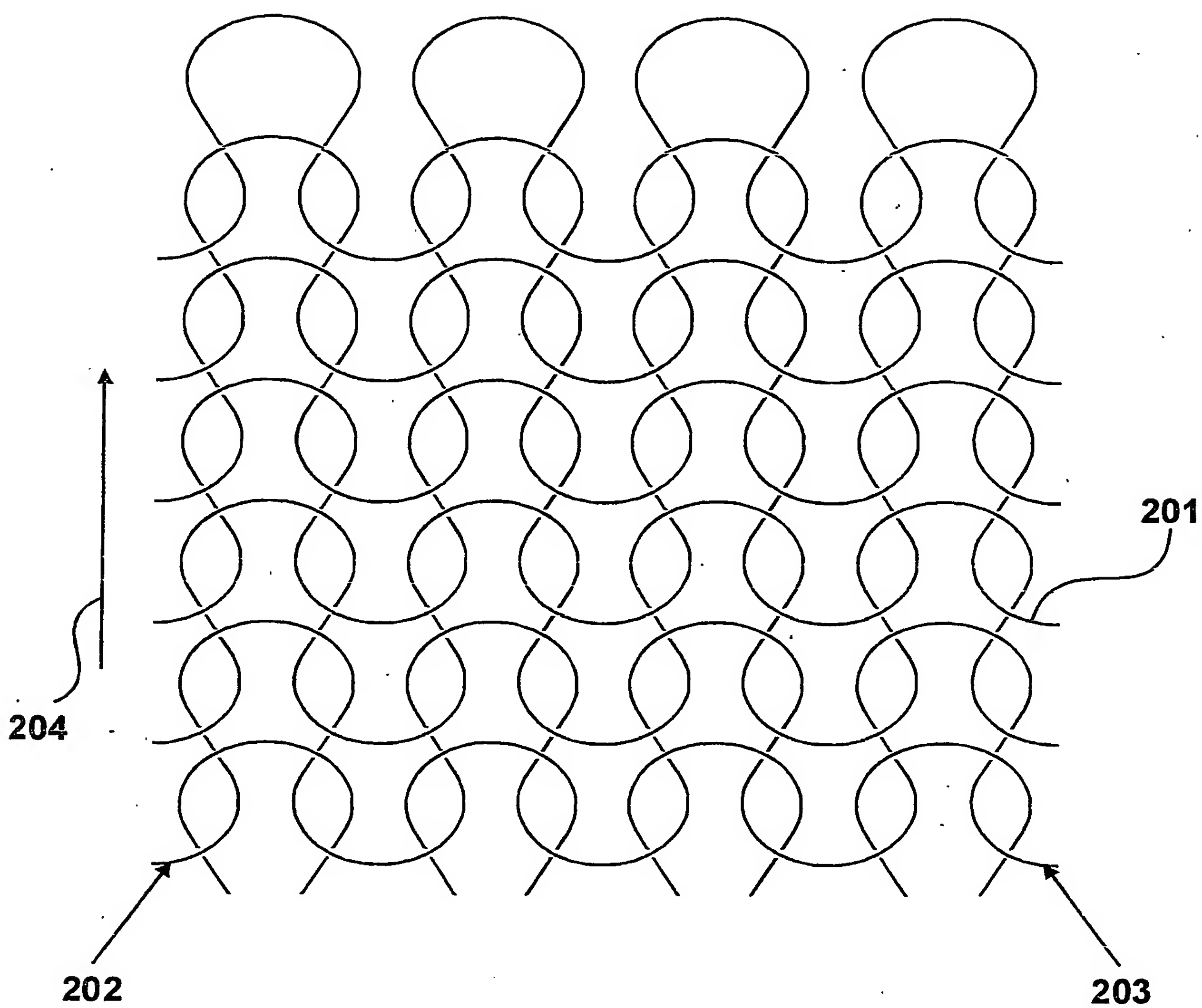

Figure 2

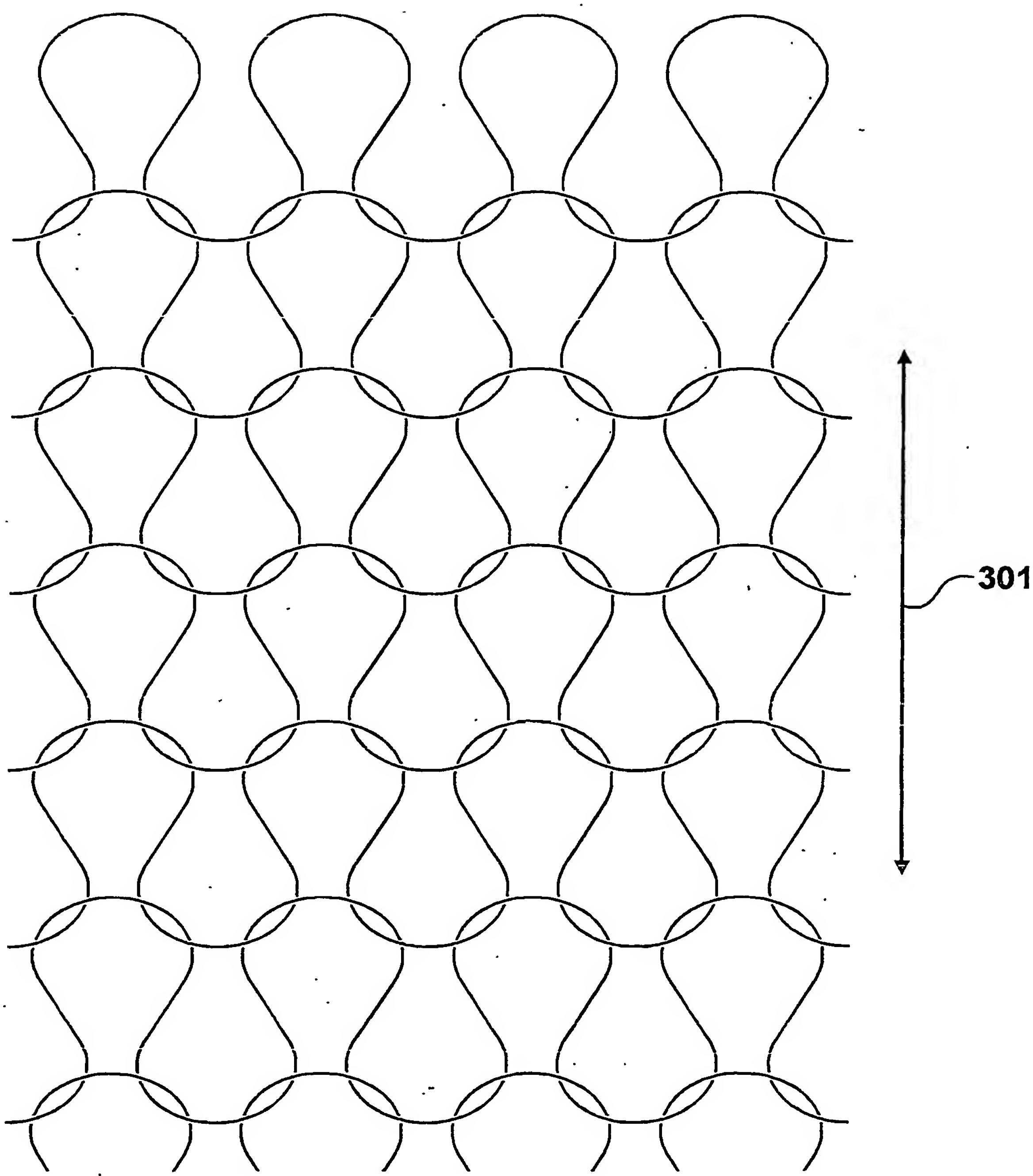

Figure 3

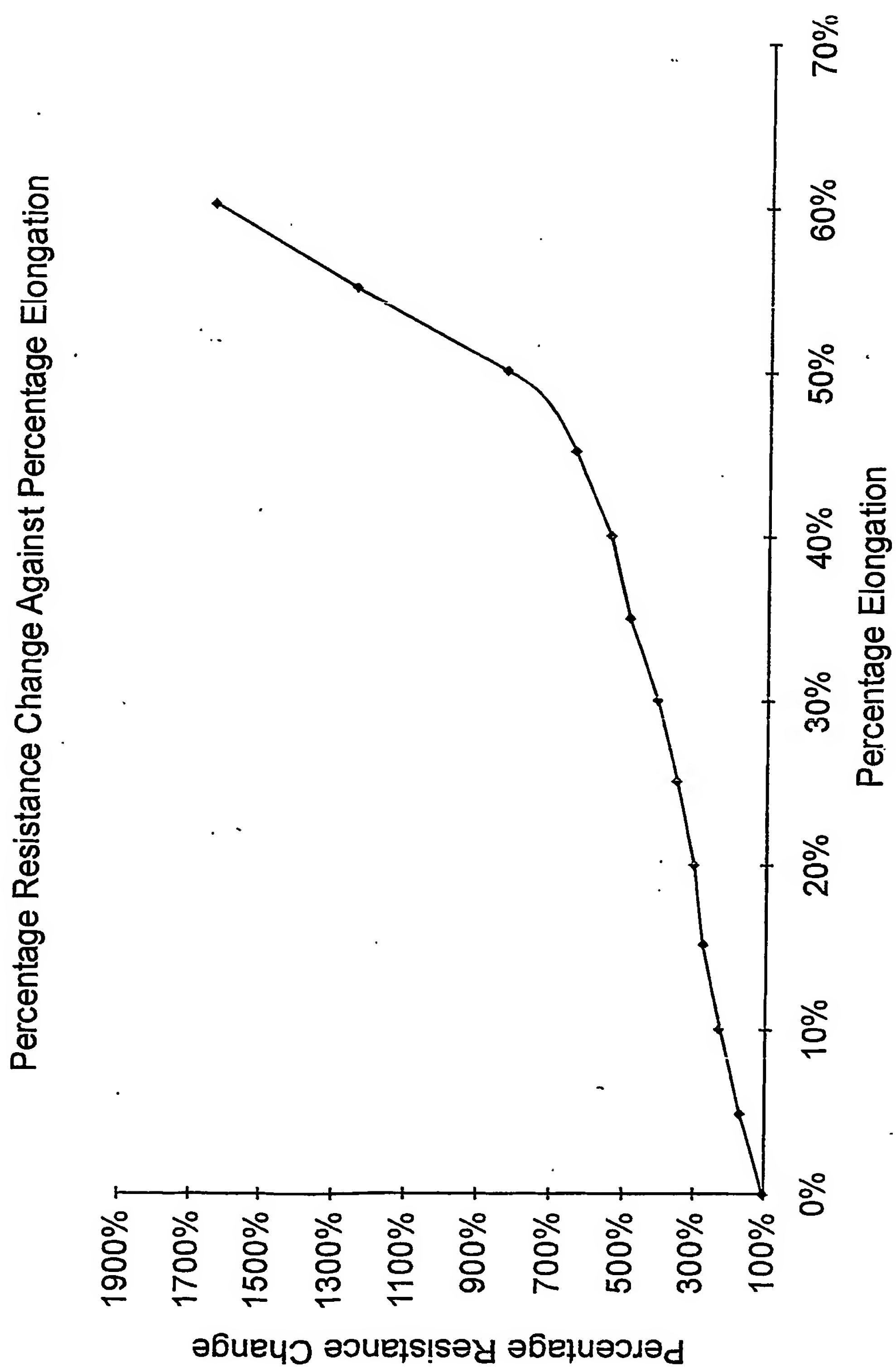
Percentage Resistance Change Against Percentage Elongation
Percentage Resistance Change
1900%
1700%
1500%
1300%
1100%
900%
700%
500%
300%
100%
0%
10%
20%
30%
40%
50%
60%
70%
Percentage Elongation

Figure 4

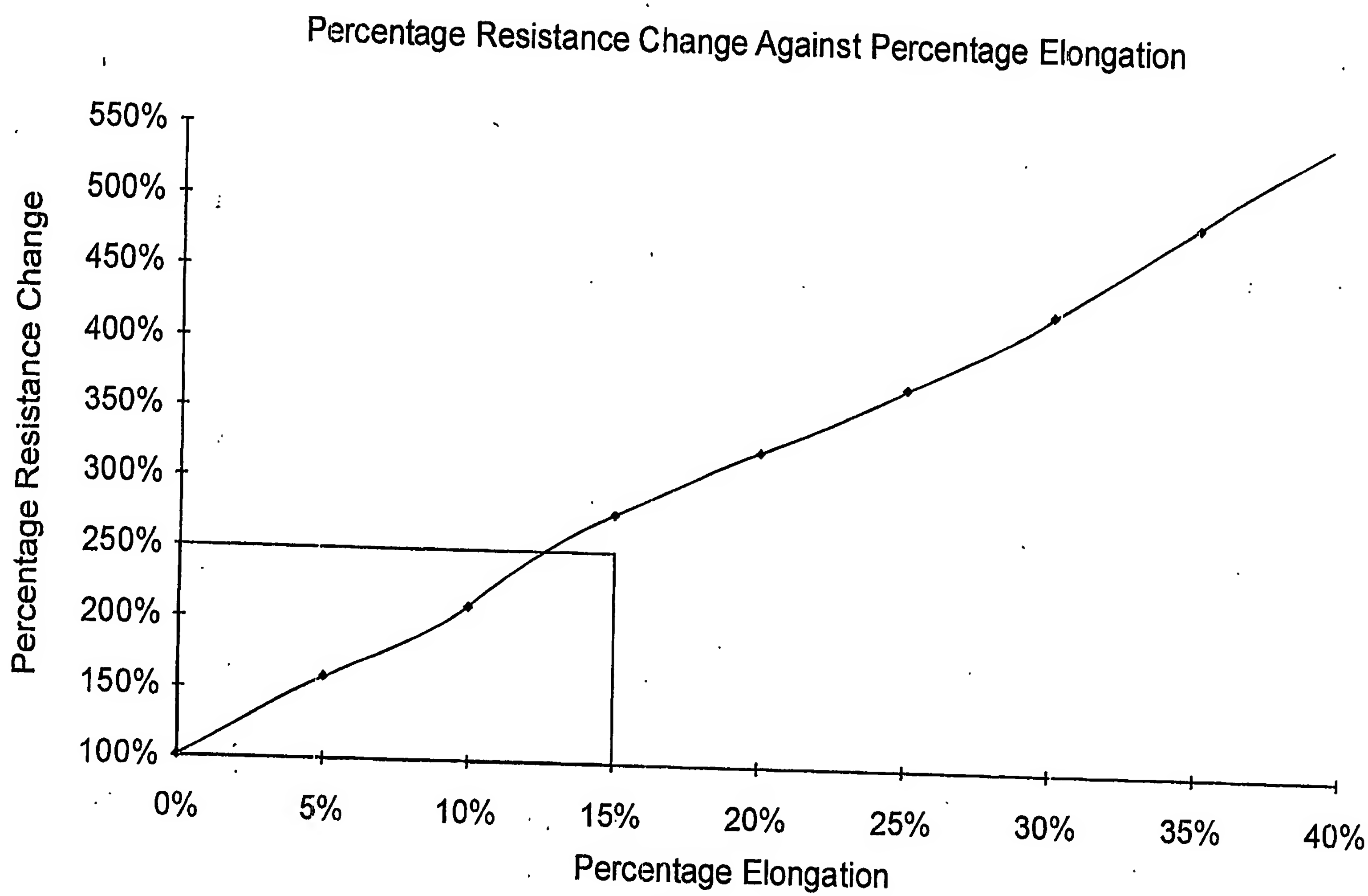
Percentage Resistance Change Against Percentage Elongation
Percentage Resistance Change
550%
500%
450%
400%
350%
300%
250%
200%
150%
100%
0%
5%
10%
15%
20%
25%
30%
35%
40%
Percentage Elongation

Figure 5

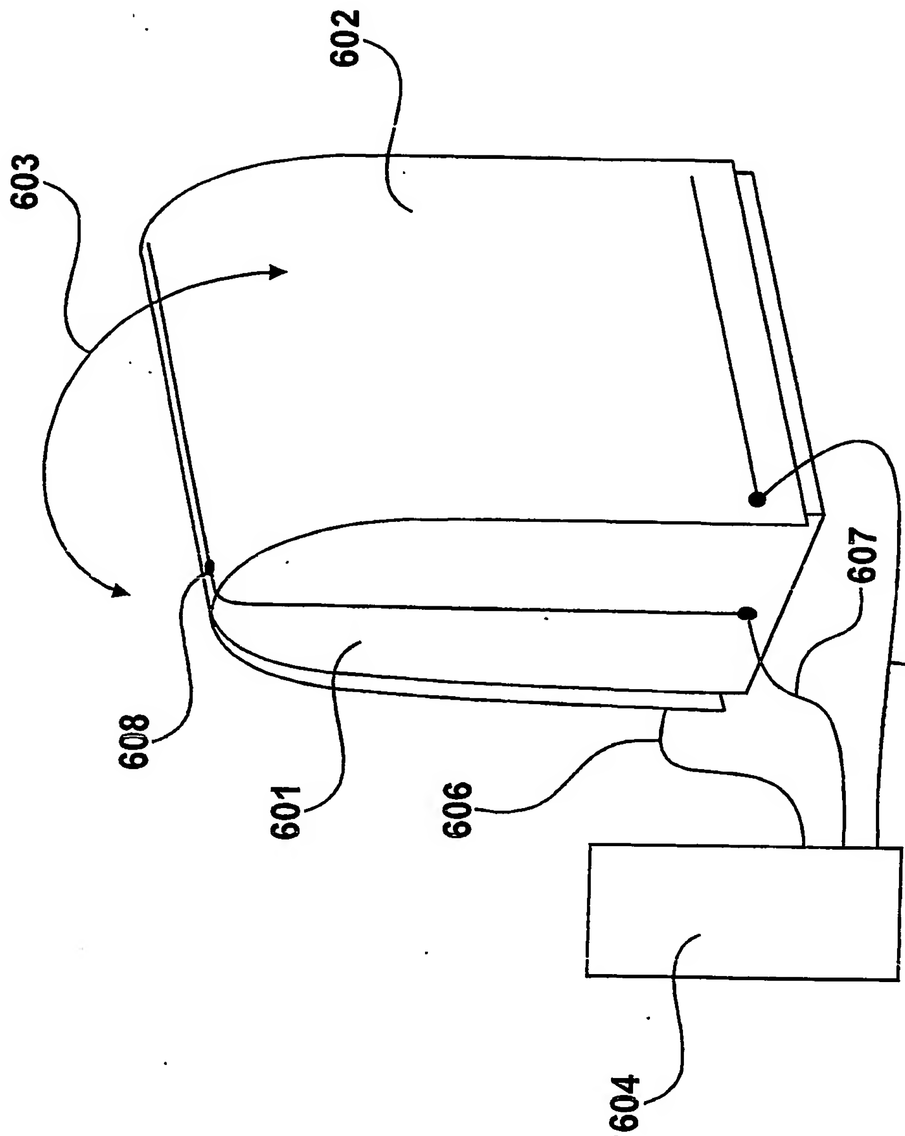

Figure 6

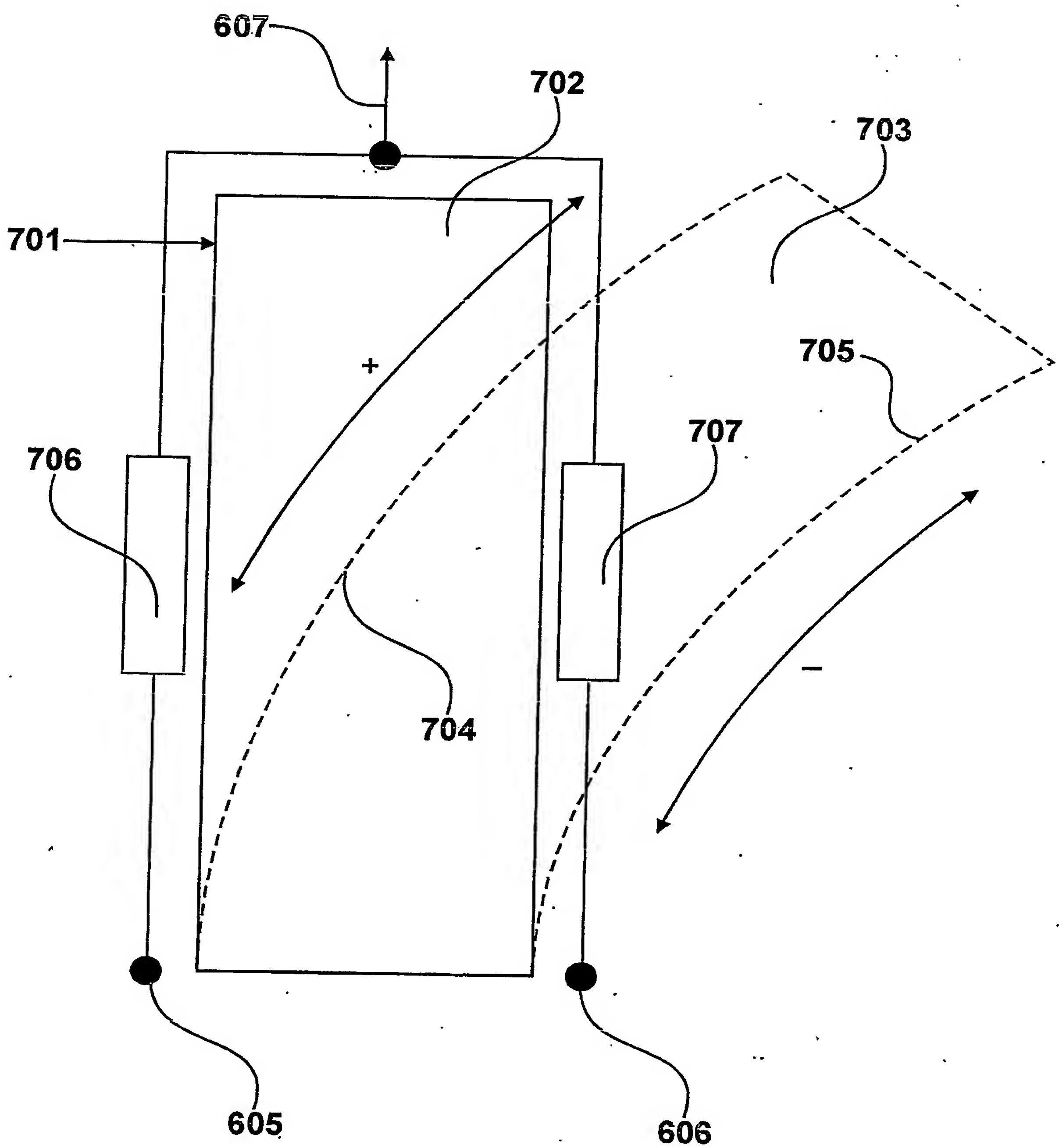

Figure 7

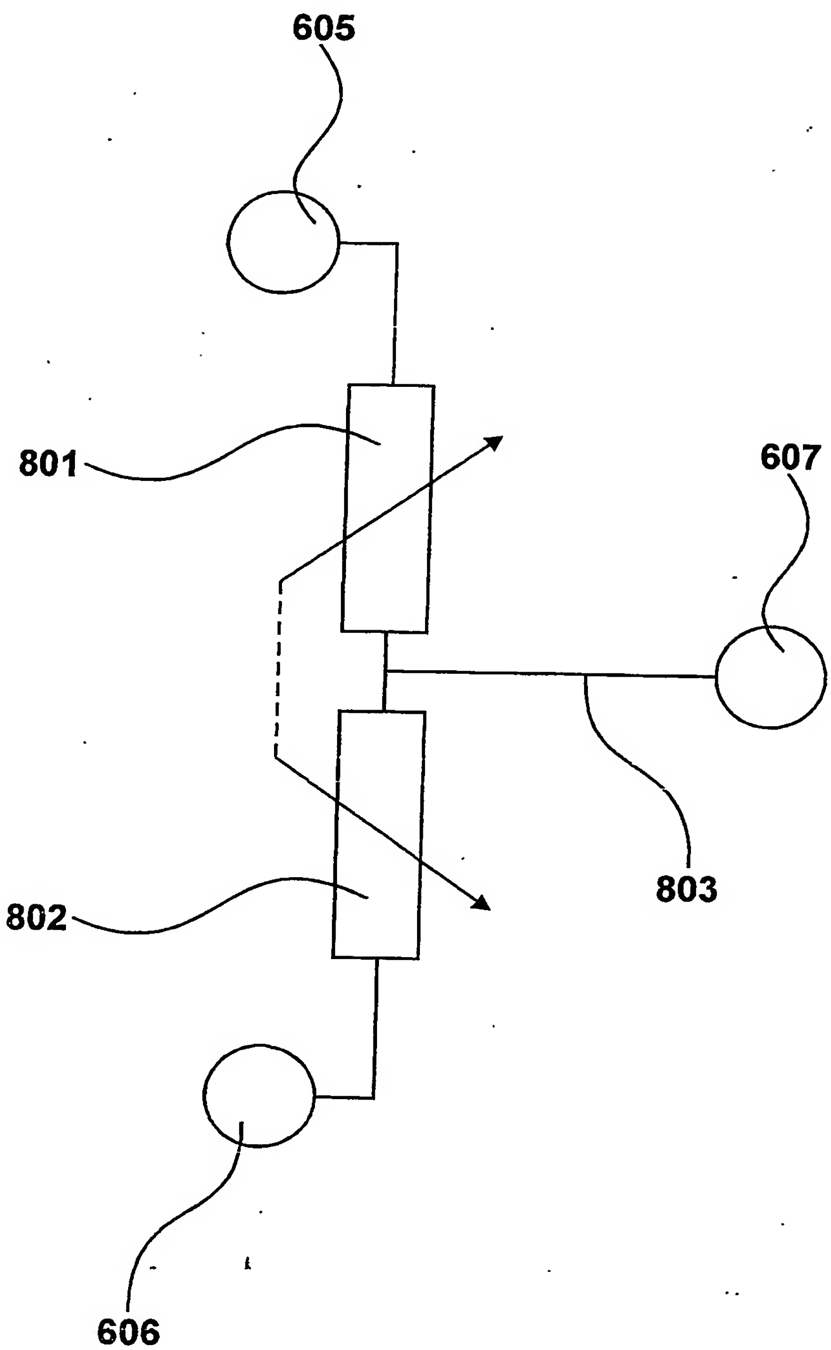

Figure 8

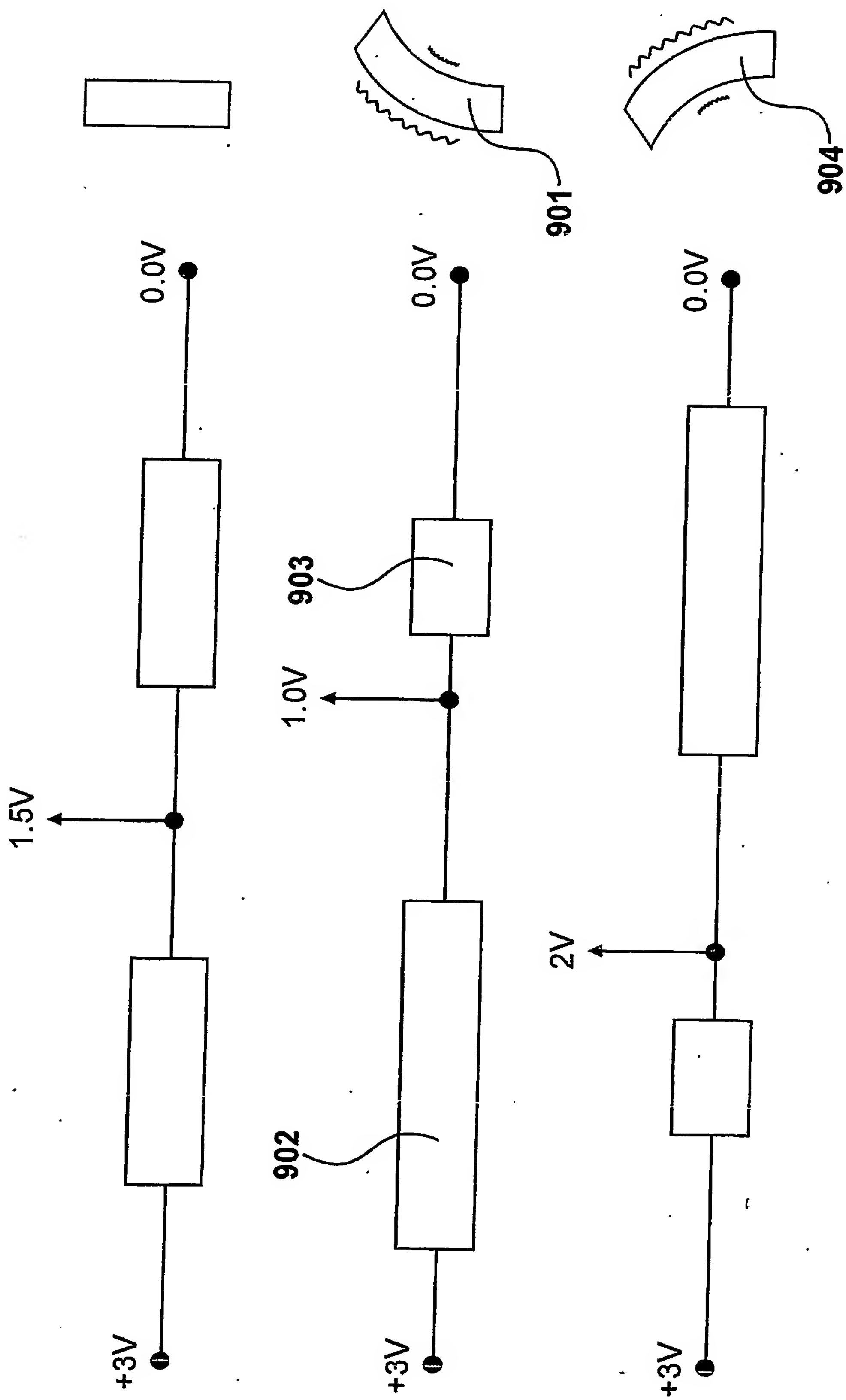

Figure 9

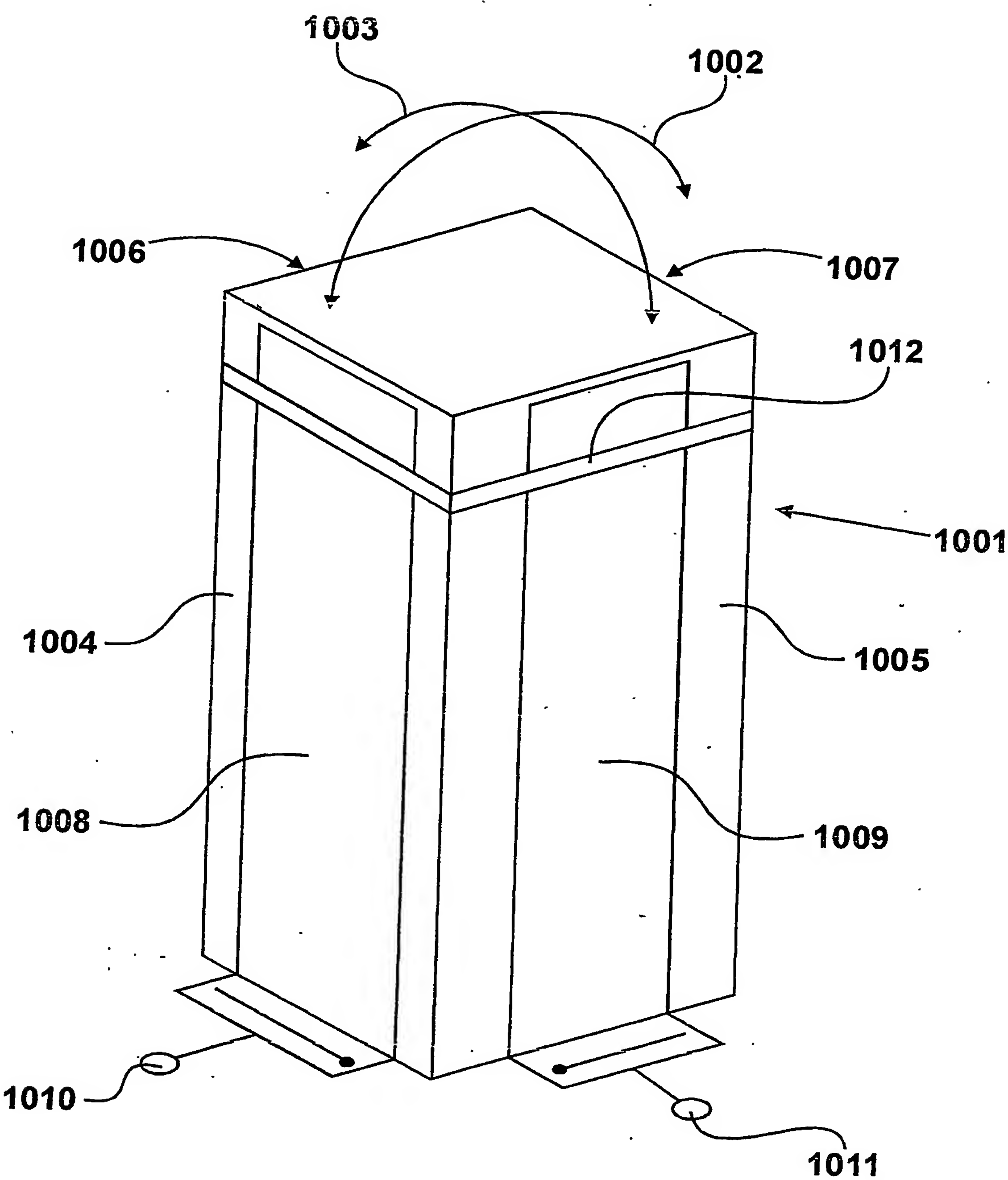

Figure 10

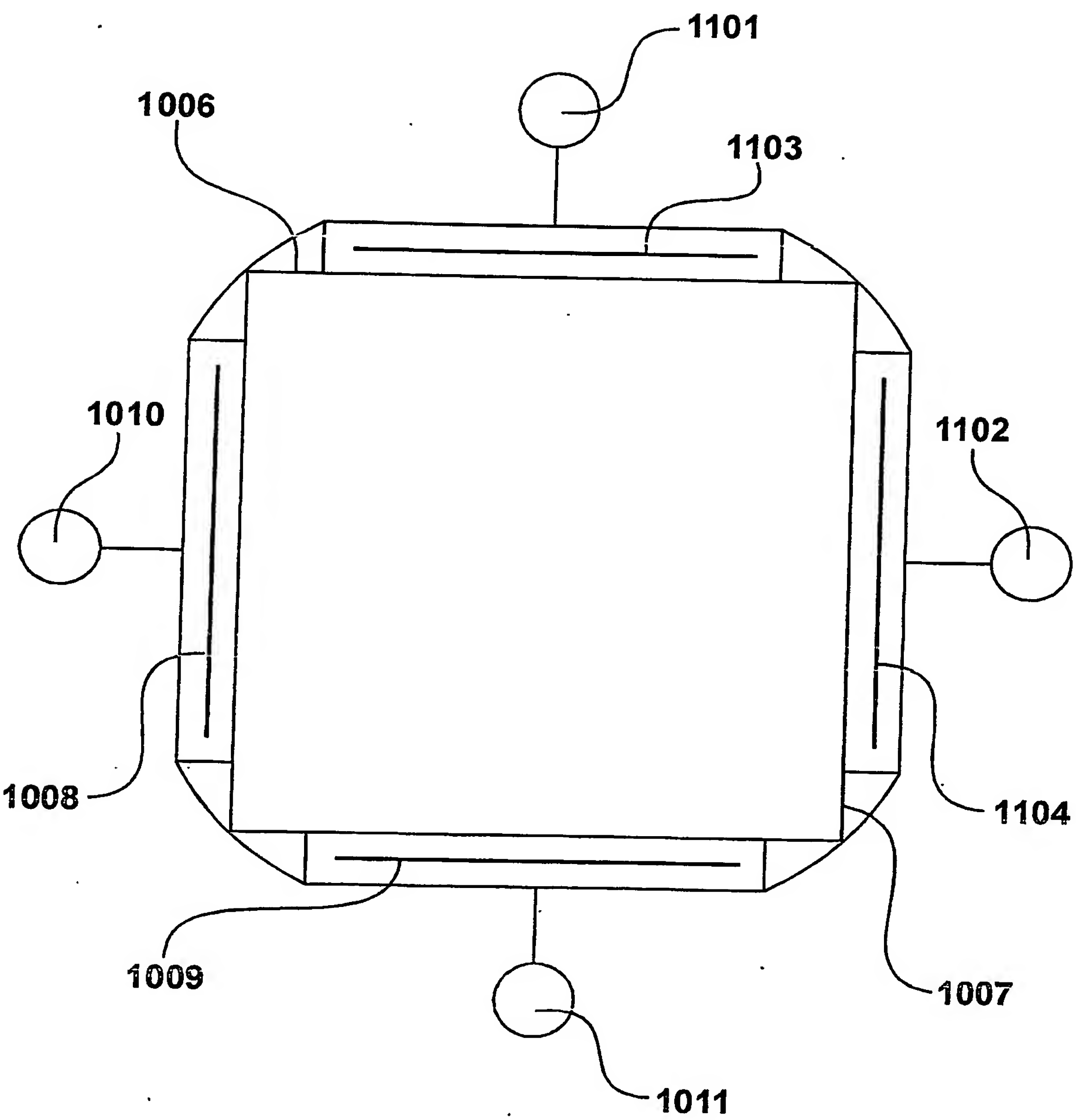

Figure 11

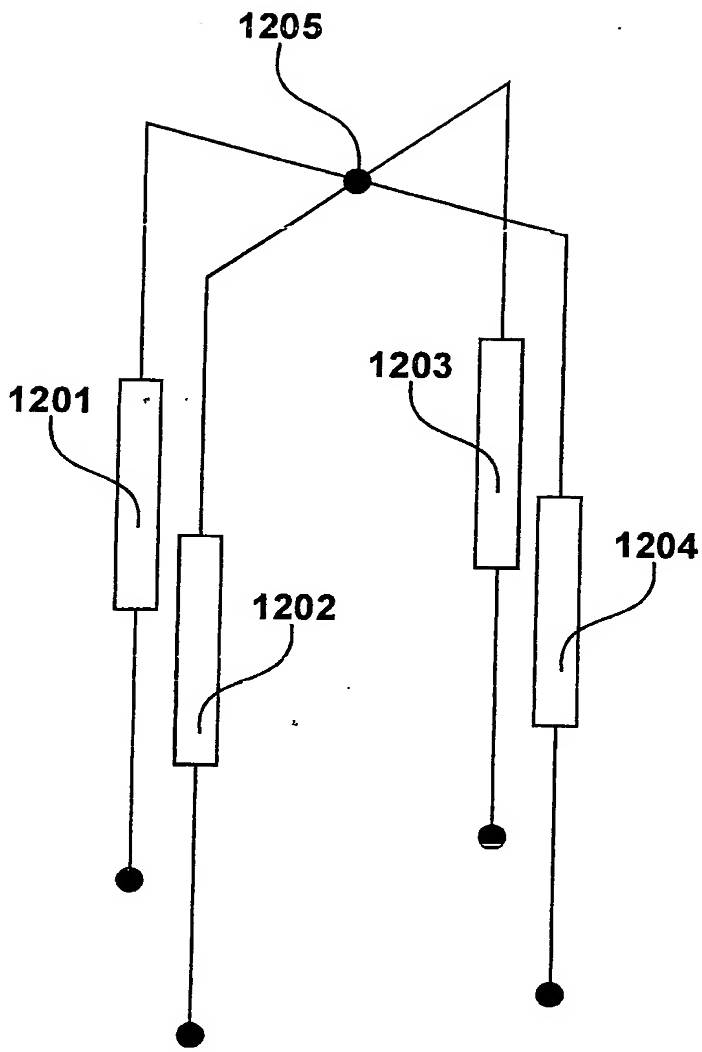

Figure 12

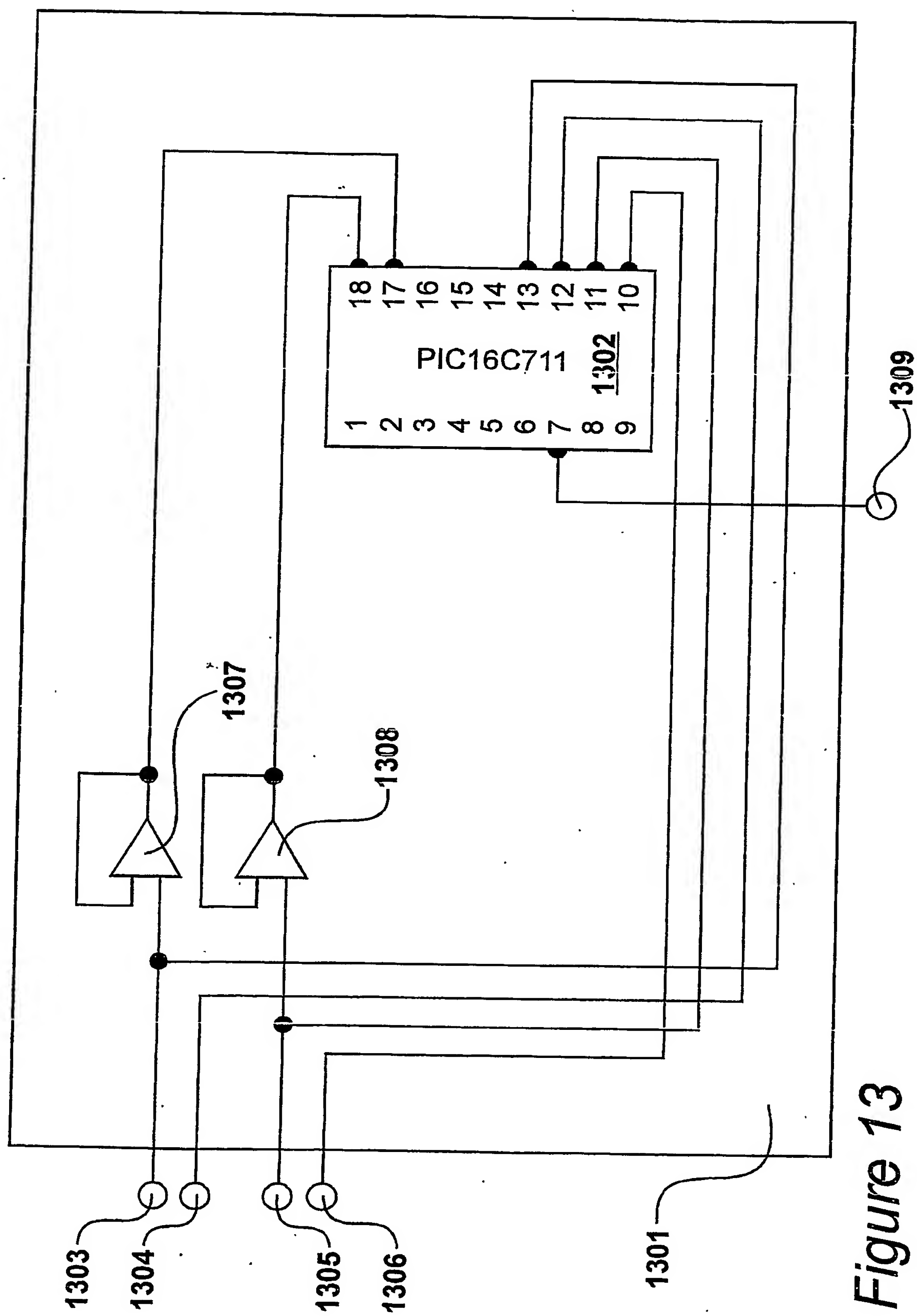
PIC16C711
1302
18 17 16 15 14 13 12 11 10
1 2 3 4 5 6 7 8 9
1307
1308
1309
1303
1304
1305
1306
1301

Figure 13

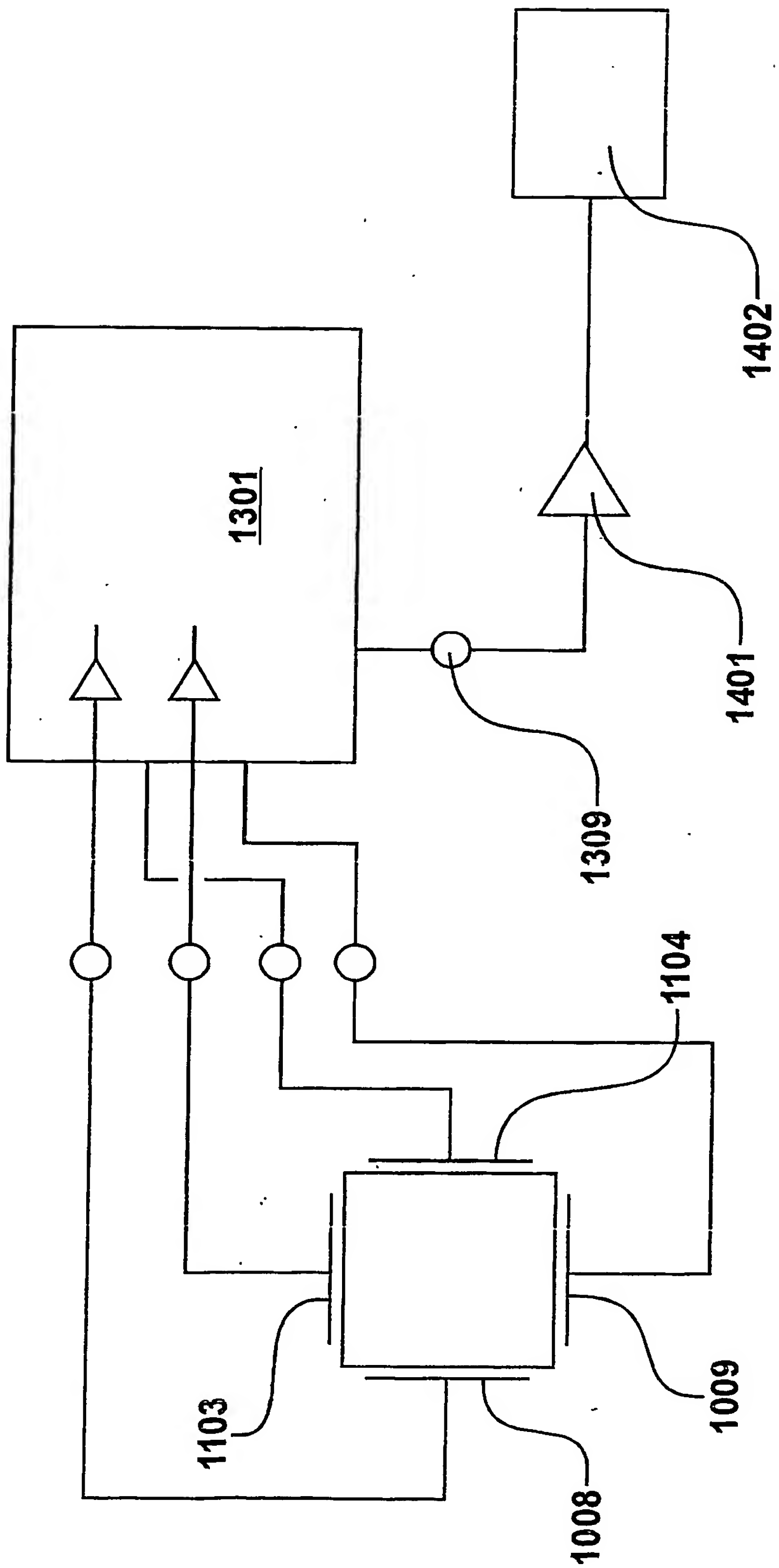

Figure 14

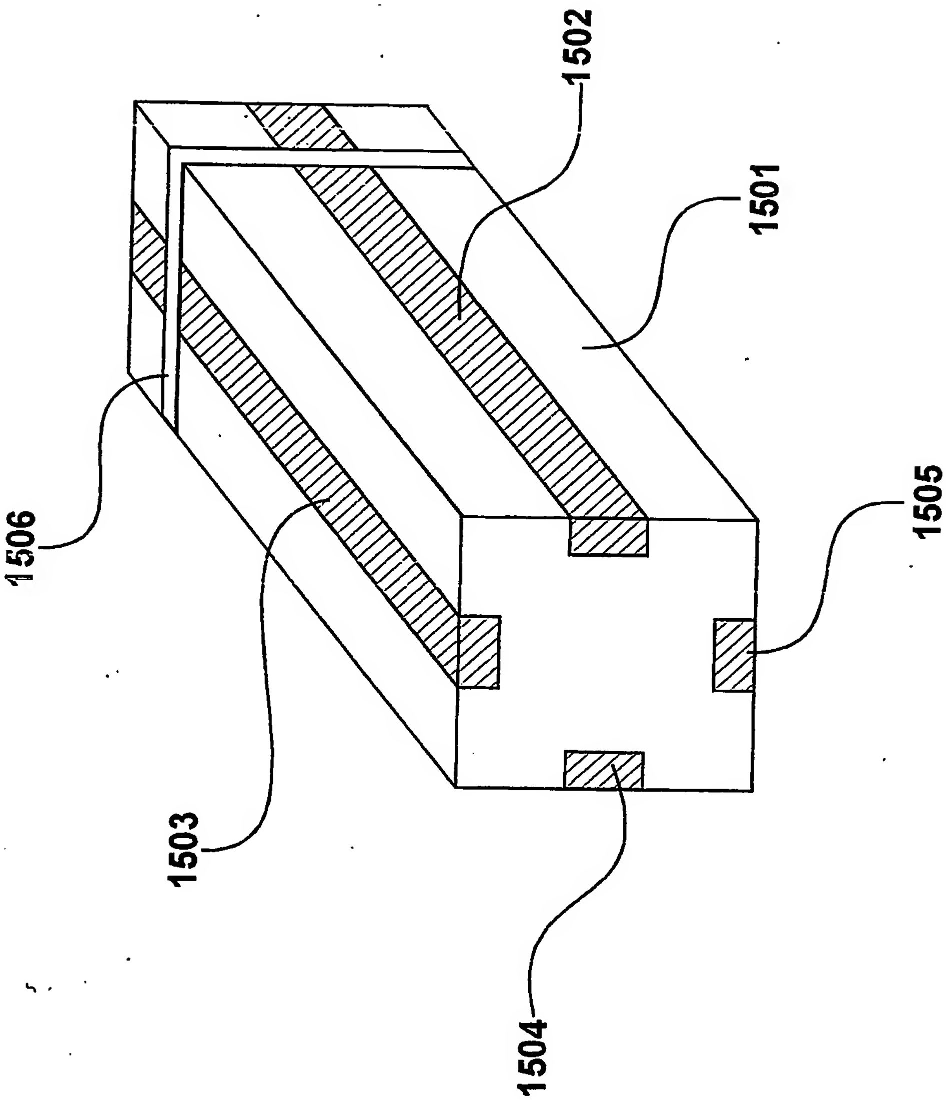

Figure 15

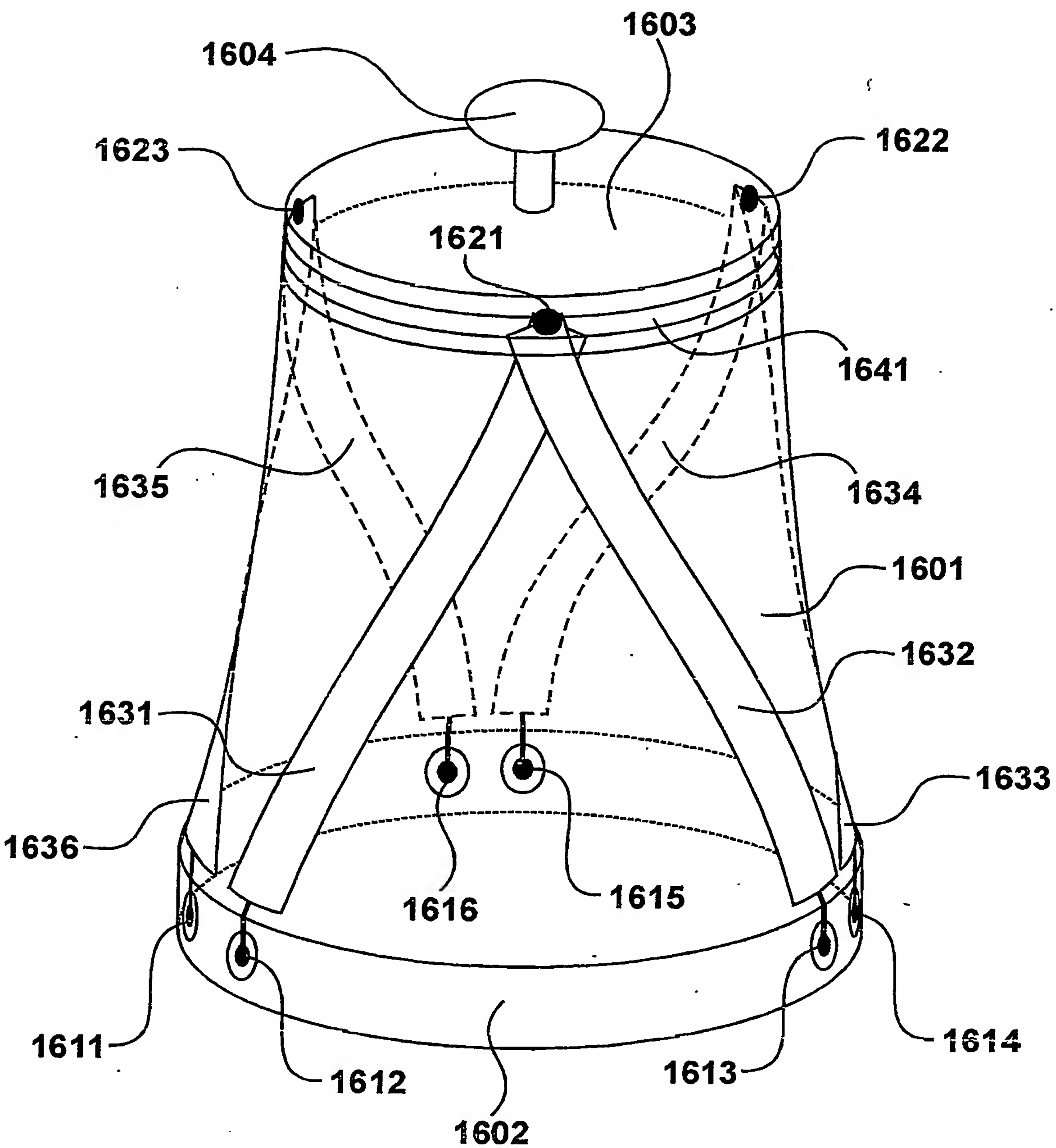
1604
1603
1623
1622
1621
1641
1635
1634
1601
1632
1631
1633
1636
1616
1615
1611
1612
1613
1614
1602

Figure 16

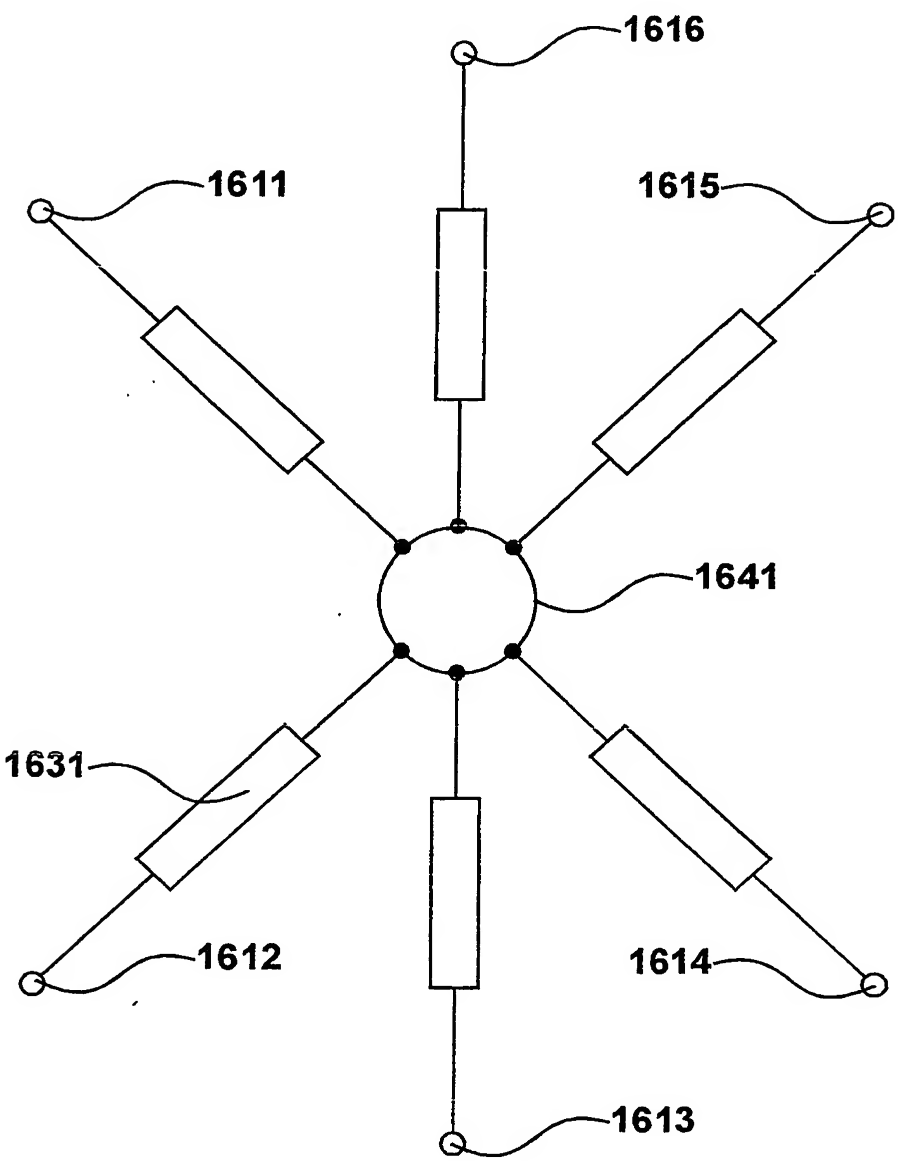

Figure 17

	1612	1613	1614	1615	1616	1611
1701	Vin	0	Vout	-	-	-
1702	-	Vin	0	Vout	-	-
1703	-	-	Vin	0	Vout	-
1704	-	-	-	Vin	0	Vout
1705	Vout	-	-	-	Vin	0
1706	0	Vout	-	-		Vin
1707	+V	I				
1708			+V	I		
1709					+V	I

Figure 18

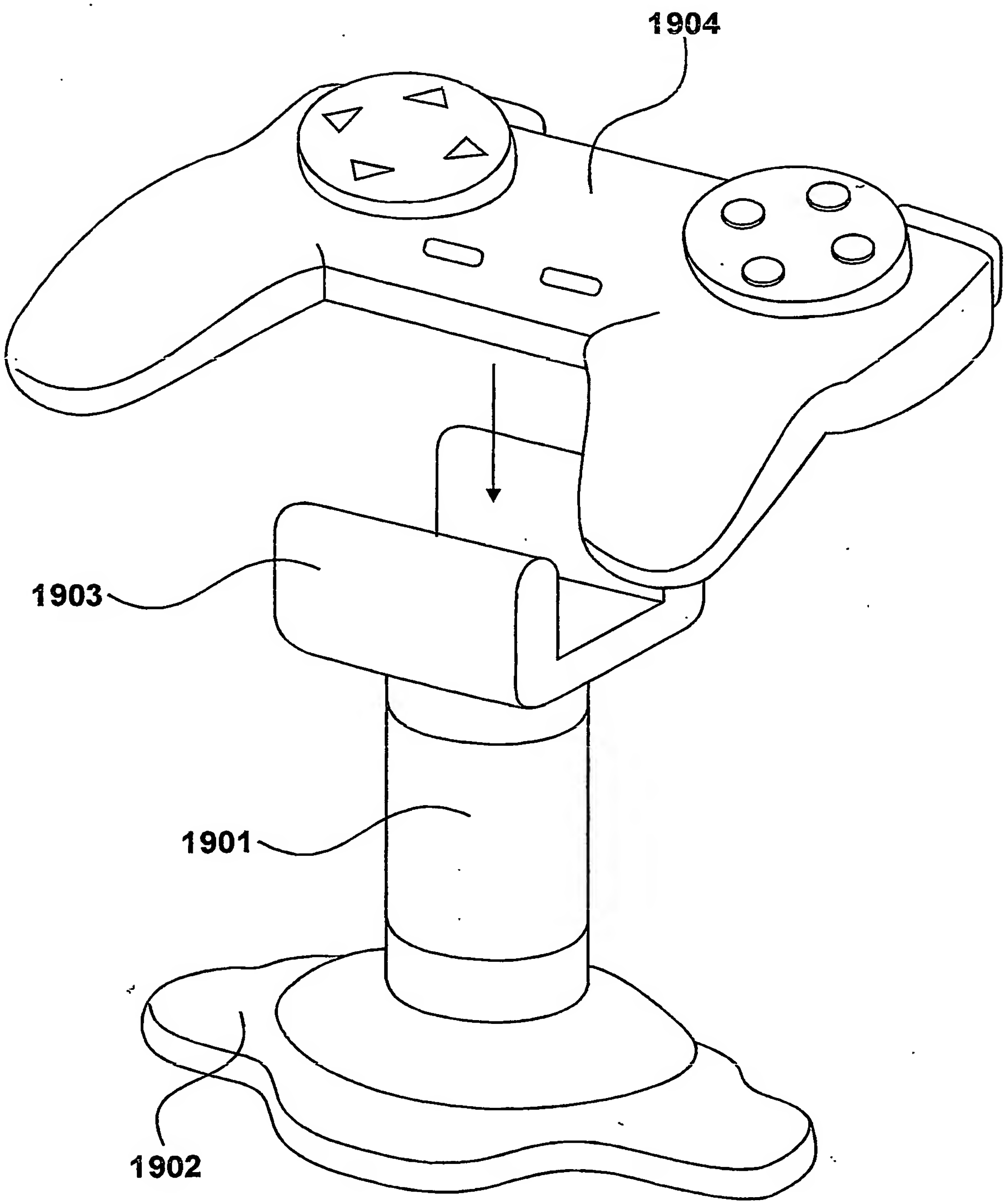

Figure 19

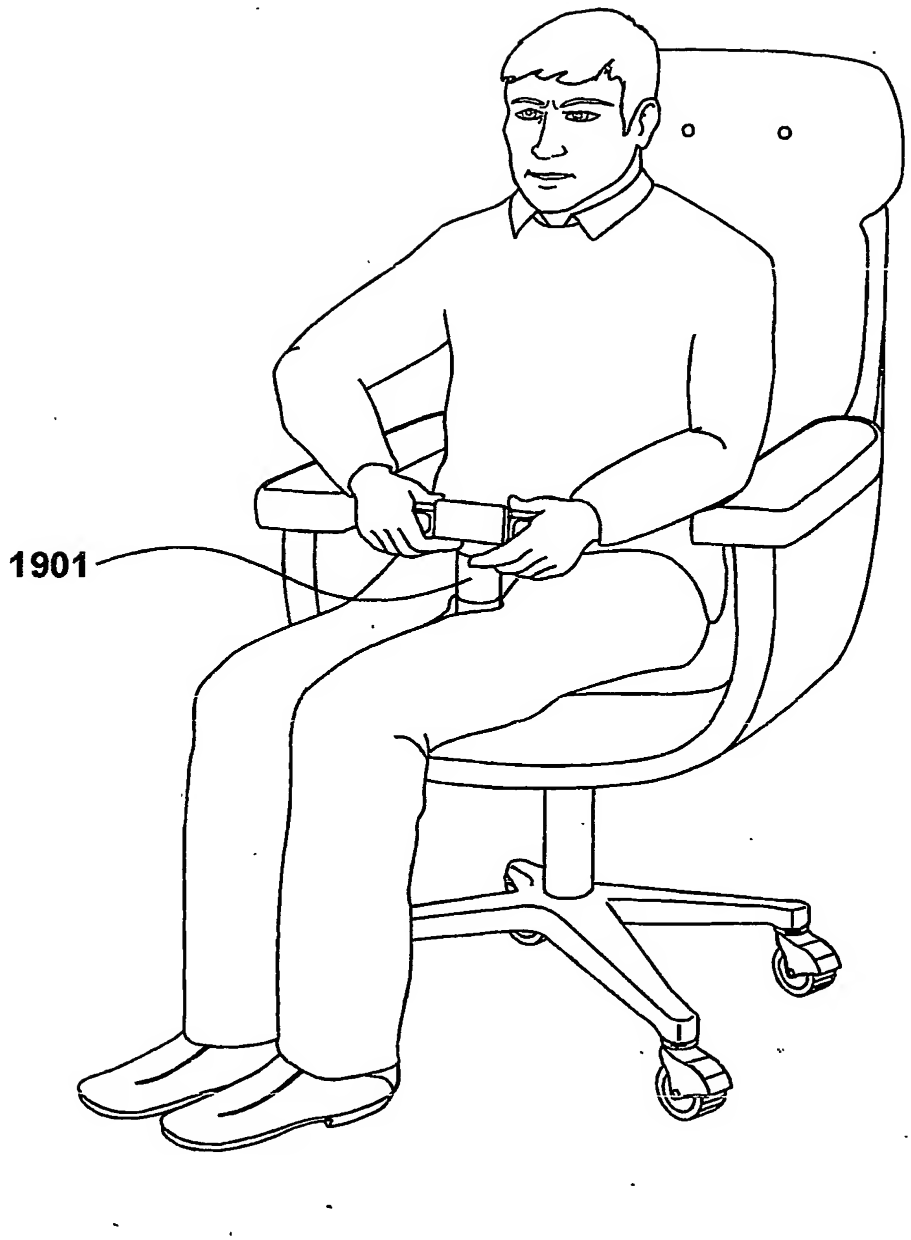

Figure 20

PCT Application
PCT/GB2004/000060